

Ref # 44

UNITED STATES DEPARTMENT OF AGRICULTURE

BUREAU OF ENTOMOLOGY

FOREST INSECT INVESTIGATIONS

THE ROLE OF FOREST INSECTS
IN RESPECT TO
TIMBER DAMAGE IN THE SMELTER FUME AREA
NEAR NORTHPORT, WASHINGTON

By
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and
J. C. Evenden, Entomologist

Bureau of Entomology
U. S. Department of Agriculture

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Refer to file
Proj. W-8

Forest Insect Field Station,
Coeur d'Alene, Idaho,
December 12, 1929.

Dr. F. C. Craighead,
Washington, D. C.

Dear Doctor Craighead:

Please find enclosed six copies of a report covering Mr. Keen's and my examination of the Northport smelter area. Mr. Keen did the major portion of the work in connection with this report. He tabulated our data, prepared the map, and outlined a rough of the body of the report. This material was forwarded to this station for final typing with the statement that I was to edit and make any changes which I saw fit. Mr. Balch and I spent a little time on this report eliminating a few statements which I felt were irrelevant and which we might have difficulty in supporting. I trust that this report as prepared will meet with your approval.

Relative to the rumors you have heard in regard to the hearing scheduled on January 23 in Washington, D. C., I might say we not only heard these rumors in Northport but were told rather emphatically we would be called on to attend this hearing. I suppose that there is nothing much that needs to be said relative to this rumor. To use your statement I can say that although I would like to again visit Washington and see you all again, I agree that it would certainly mess up my winter's work. However, as stated, I guess there is nothing we can do about it.

Sincerely yours,

James C. Hyenden

James C. Hyenden
Entomologist

6 enclosures

cc to Mr. Miller
Mr. Keen ✓

THE ROLE OF FOREST INSECTS
IN RESPECT TO
TIMBER DAMAGE IN THE SHELTER PULP AREA
NEAR NORTHPORT, WASHINGTON

FOREWORD

Rather late in the season of 1929 the assistance of the Bureau of Entomology, Department of Agriculture, was requested by the commission studying the damage to timber and field crops in the vicinity of Northport, Washington. The Bureau of Entomology was requested to furnish this commission with information relative to the part insects were contributing towards the death of forest trees within this region. Following this request Mr. F. P. Keen spent a week in the Northport area determining the forest insects present and appraising their importance as destroyers of the forests of that region. A report covering Mr. Keen's examination was submitted early in August, a copy of which is appended to this additional statement. In November the Bureau of Entomology was again requested to detail Messrs. Keen and Evenden to this region for the purpose of securing additional data. Immediately following this request the writers of this report spent seven field days in the region, at which time a number of temporary sample plots were established and examined.

Forest insects are an important agency of timber destruction in nearly every forested area. Such destruction may vary from an

annual loss of a few trees per section to an epidemic condition which destroys a large per cent of the total timber volume within a few years. Of the tremendous number of different insect species encountered within our forests only relatively few can be considered capable of attacking and killing perfectly healthy trees. Many species are secondary in character and confine their attacks to unhealthy and weakened trees. Some species of tree-killing barkbeetles, though capable of attacking and killing perfectly healthy trees, would seem at certain times to prefer weakened and decadent ones. Trees weakened by fire, drought, mechanical injuries, defoliation, etc., are particularly susceptible to the attack of both primary and secondary insects.

In the Northport area where smelter fumes are reported to be of serious consequence, rather large volumes of timber have been destroyed through the activity of some one, or a combination of a number of, destructive agencies. The degree to which insects are responsible for the death of these trees, and the extent to which an increase in insect activity has been brought about by the weakening of the trees through the reported damage to the foliage by smelter fumes, are indeed rather important questions. A satisfactory answer to these questions must be secured before the primary agency responsible for this destruction can be determined. With some tree species and insects the problem encountered was not so very difficult, but with other trees, and their associated insects, it is believed that a satisfactory answer can only be reached by following marked trees from the time the first external physical injury is recorded until the time of their death.

Though the writers of this report feel that their reaction to conditions within the area examined has been based upon rather conclusive and impartially selected data, it is realized that a mass of evidence was not secured. This reaction was based upon the examination of over 1,000 trees, selected from different portions of the area, and the experience of the writers in forest entomological work. It is felt that the Bureau of Entomology was not given a satisfactory opportunity to study the problem. On very short notice this Bureau was asked to answer questions having an important bearing upon the entire situation. Though, as stated, the writers feel that their position has been based upon evidence entirely satisfactory to themselves, it is realized that a mass of supporting data could only be secured through the assignment of an entomologist to the project for an extended period.

GENERAL CONDITION OF THE AREAS EXAMINED

During the course of this examination a number of rather complex factors were encountered which no doubt were contributing to the general condition of the timber within the Northport area. Weather conditions, fire, timber cutting, insects, disease, reported smelter fumes, etc., are no doubt the most important of these agencies and must be considered as playing a more or less important part in the destruction of timber. To separate the importance of insects from the other factors which might have contributed towards the death of the trees was often found to be practically impossible. In the short time available for this examination

an attempt was made to secure as much data as possible relative to the character (primary, secondary, or none) of the insect work within the dead and dying trees throughout the area. Examinations were also made of areas outside the region of reported damage, in order to secure more definite information relative to the abundance of destructive insects in the two zones.

It is possible that the past two or three dry years might have had a weakening influence upon the yellow pine trees within this region, making them more susceptible to the attacks of the western pine beetle. However, if this were the case the same conditions would exist throughout the entire region, which is not evidenced.

Until recent years very little attention has been given to fire suppression and as a consequence a large per cent of the entire forested area has been burned more or less repeatedly. The effect of the more recent fires is very evident and large areas have been killed outright. The effect, however, of the older fires is less evident and it is difficult to determine to what extent the death of trees is due to weakening by fire.

Apparently disease has played its part in killing some trees — Douglas fir particularly — and many dead or dying trees containing broods of bark beetles at the time of the examination were dying principally from the effects of the honey fungus (*Armillaria mellea*).

In addition to the environmental factors mentioned above there are a multitude of insects attacking ten species of coniferous trees to be considered. As previously stated, it is a very complex situation,

one which cannot be satisfactorily solved in a few weeks or months of study, nor summarized in a few terse paragraphs.

The report issued by Keen following his investigations in July summarizes the general conditions of the area relative to the different tree pests and the situation in different parts of the area, and is made a part of this report. The recent investigation by Keen and Evenden brought to light very little which would change that report but supplemented it by securing additional quantitative data for different parts of the area. These data are summarized in the following pages.

ZONES OF TIMBER DESTRUCTION

As a result of this examination two zones of timber damage within the area reputed to be damaged by smelter fumes were clearly recognized. These zones are outlined on the attached map and described as follows.

ZONE 1. This is a zone of fairly heavy timber damage extending along the Columbia River gorge from the International Boundary to a point about six miles below Northport. In this area the timber stand has been rather badly depleted through logging, forest fires, and what was assumed to be smelter fumes, so that only small patches of living trees could be found. On most of the yellow pine and Douglas fir trees only very scanty foliage is present, usually consisting of only one year's growth of needles. The Douglas firs are dying back from the top and inwardly from the tips of the lateral branches. All of the trees are of an unhealthy color and show every evidence of being in a very sickly or decadent condition. This condition of the foliage was not due to insect defoliation but some

abnormal condition, presumably earlier fires. In this zone the loss of timber has been rather heavy. Insects may have contributed somewhat to this destruction, but it is believed only in a minor way.

ZONE 2. This is a zone of medium timber damage with somewhat more timber dying than in adjacent outside areas. It borders the zone of heavy damage in the northern part of the area and follows along the Columbia River gorge to Marcus, but does not extend very far back into any of the side tributaries of the river. Throughout this zone the Douglas fir and yellow pine trees show some defoliation with, for the most part, only one or two years of needle growth remaining. The foliage was often discolored. Insects were not responsible for this defoliation or for the discoloration. Dead and dying trees were less abundant than in Zone 1 but much more prevalent than in areas outside these zones of damage. Primary insects were found to be attacking and apparently killing more trees in this region than in Zone 1. In this zone one large group of lodgepole and one large patch of yellow pine showed primary attacks of Ips. (Sample Plots #7 and 12). There were also many other dying and dead trees showing no insect attack whatever which were apparently dying from other causes.

OUTSIDE ZONE. Outside the first and second zone of insect damage was an area in which dying and dead trees were very difficult to find, but those which were located showed the usual percentage of insect attacks that one could expect to find in any similar forested area. Foliage conditions were apparently normal, with from 3 to 5 years of needle growth on both the yellow pines and Douglas firs.

Douglas fir in places were apparently being killed by the honey fungus (Armillaria mellea). Some trees were found with no insect work whatever, but with the root collar swollen and completely killed by what was determined as the honey fungus. In other places the Douglas fir bark beetle (Dendroctonus ponderosae) and the Douglas fir flatheaded borer (Heterophila drummii) were killing isolated individuals and groups of apparently healthy trees. At the higher elevations large areas of mature Douglas fir have been severely defoliated by the Douglas fir tussock moth (Panorpanna resinitana MoB) and many of the trees within these areas will undoubtedly die. The areas showing defoliation by the tussock moth, which are known to the writers, are shown on the attached map. In no known cases did the defoliation extend down into the zones of damage as shown on the map.

Yellow pine in the outside zone showed some death from western pine beetle and a few spots where large groups had been killed by the engraver beetles, Ips latens and Ips grandis, but the death of trees was much less per unit area than in the zones of damage, and no more than would normally be expected to occur in practically all yellow pine stands.

THE DATA SECURED

In order to supplement the general observations made in different portions of the area, sample tree counts were made of sickly, dying, and dead Douglas fir and western yellow pine trees, and as far as possible the responsibility for death or injury determined.

Plots were selected in typical portions of each zone in mature timber stands where the trees had not been weakened by recent fires. An attempt was made to secure sufficient plots to cover all conditions such as exposure, site, etc. Approximately 100 sickly, dying, or dead trees in each plot were examined and classified. Plots in the first and second zone varied from 2 to 160 acres in extent, but in the outside zone the dead and dying trees were so scattered that it was necessary to cover a large acreage in order to secure a representative series.

Unless dying trees are examined within a few days subsequent to the attack by barkbeetles, it is very difficult to determine if the trees were in a weakened condition just previous to the insect attack. This fact complicated the collection of data very materially. At the time of the November examination, as the attacks for the season had been made several weeks before, there were very few cases where one could be positive of the primary or secondary character of a 1939 *Dendroctonus* attack.

All sickly, dying, and dead trees examined were listed under their respective headings, and subdivided still further as to character of foliage, whether good, fair, or poor. Then the trees falling into each group were divided into four classes as to insect injury: none, secondary, doubtful, and primary. Under the heading of "none" were listed such sickly, dying, or dead trees as showed no evidence of insect attack and were clearly dying or dead from other causes. Under "secondary" were tabulated trees which showed the work of only secondary insects or primary

insects which were clearly working in a secondary capacity. Trees which showed the attacks of tree-killing barkbeetles but which may have been weakened by other contributory agencies, perhaps primarily responsible for their death, were placed in the "doubtful" column. In cases where it was clearly evident that insects were the primary cause of injury or death, the trees were tabulated in the "primary" column.

In each locality trees were mechanically selected for examination which usually included all the dying or dead trees on a plot varying from 40 to 80 acres in area. Plots were selected where the trees were growing under apparently normal conditions of soil and exposure. Conditions on the different plots are described in detail in the appendix to this report.

SUMMARIZED DATA FROM PLOT EXAMINATIONS

Comparing the statistical data which were secured on Douglas fir and western yellow pine for each of the three zones we find some rather striking differences. These data are shown in Tables 1 and 2.

In Table 1, where the conditions of the Douglas fir trees within the different zones are compared, we note first that the condition of the green trees where the foliage is found to be sparse and sickly is in no case a result of primary insect attack. The areas of tussock moth defoliation where 100 per cent of the injury is due to this moth, have been excluded from this examination. These areas are outside the zones of damage as shown on the attached map and in no case was any tussock moth work found within these zones, so work of this insect can be eliminated from consideration in this problem.

With dying trees there is a very evident trend from a low degree of insect responsibility for tree destruction in Zone 1 to a high degree in the outer zone. Thus, primary attacks increased from none in Zone 1 to 43 per cent in the outer zone, while trees showing no insect work decreased from 72 per cent in Zone 1 to 12 per cent in the outer zone.

The same tendency as shown for dying trees is also true for the dead trees. However, in this tree class it was very difficult to definitely state that the insect attack was or was not primary since the previous history of the tree was unknown. However, those trees classed as doubtfully killed by insects increased from 20 per cent in Zone 1 to 35 per cent in the outer zone, while those showing no insect work whatever decreased from 38 per cent in Zone 1 to 6 per cent in the outer zone.

In Table 2 the same comparisons are made for western yellow pine. Nearly 100 per cent of the trees in a sickly condition in Zones 1 and 2 showed no insect work which would account for this condition. No sickly yellow pines were found in the outer zone. Any trees within this region with fading foliage were found to be dying from the effects of primary barkbeetle attacks.

Dying trees would seem to offer the most reliable data from which deductions can be drawn as to the importance of insects as timber destroyers within this region. From the tabulation of this class of trees it is shown that there is a direct trend from little insect responsibility for timber destruction in Zone 1 to a rather high responsibility in the outside areas. From these data we also find that there is an opposite

trend in the percentage of trees showing no insect work whatever. Seventy two per cent of the dying Douglas fir trees in Zone 1 show no evidence of insect work. This figure drops to 41 per cent in Zone 2 and 12 per cent in the outside areas. With yellow pine 44 per cent of the dying trees in Zone 1 showed no insect work; 76 per cent in Zone 2, and none in the outside areas. The fact that there were more dying trees showing no insect work in Zone 2 than in Zone 1 can no doubt be explained by the fact that the boundary lines of these zones were somewhat arbitrarily drawn, and that certain portions of Zone 2 should no doubt have been included in Zone 1. This position is rather well supported by the fact that there is a similar break in the data under the "primary" insect column within the tabulation of dying yellow pine. However, this fact remains regardless of any discrepancies which may seem to occur in the data secured and which are no doubt accounted for by insufficient material. If the extremes of the data are considered and Zone 1 compared with the outside areas, there is an increase of insect responsibility in the one case and a decrease in the number of trees being destroyed with no insect attacks.

In Zone 1 there is evidently more primary damage occurring in yellow pine than in Douglas fir. In this zone 14 per cent of the dying yellow pines is listed as containing primary insect attacks, with no primary insect destruction of Douglas fir. Though, as stated, it is rather hard to draw conclusions from dead tree data, the tabulation of this material shows the same trend of insect responsibility. with

yellow pine we have 56 per cent of the trees examined listed as doubtfully primary, whereas in the outside areas there is 95 per cent doubtfully and definitely listed as primary. With Douglas fir there were no dead trees in any of the zones listed having primary insect attack. However, if we can consider the doubtful trees as an indication we have 20 per cent of the trees in Zone 1 as against 35 per cent in the outside areas.

As one moves from the heavy timber destruction in Zone 1 to the outside areas dead and dying trees become more scattered until a normal condition is reached. This information, together with the data relative to the decreased insect responsibility within the areas of heavy destruction, would seem to indicate that barkbeetles are playing a minor role in the destruction of yellow pine and Douglas fir throughout the so-called Northport smelter fume area.

F. P. Keen

F.P. Keen, Entomologist.

James C. Swanson
James C. Swanson, Entomologist

December 11, 1929.

Table 1

Douglas Fir
Pseudotsuga taxifolia

<u>Green Trees</u> Foliage sickly and sparse; cambium alive.			Percentage of Insect Responsi- bility for Condition of Trees			
<u>Zone</u>	<u>No. Plots</u>	<u>No. Trees</u>	<u>None</u>	<u>Secondary</u>	<u>Doubtful</u>	<u>Primary</u>
1	2	31	100%	0	0	0
2	3	30	87%	10%	3%	0
Outside	4	24	96%	4%	0	0

<u>Dying Trees</u> Foliage fading or green with cambium discoloring			Percentage of Insect Responsibility for Condition of Trees			
<u>Zone</u>	<u>No. Plots</u>	<u>No. Trees</u>	<u>None</u>	<u>Secondary</u>	<u>Doubtful</u>	<u>Primary</u>
1	2	36	72%	11%	17%	0
2	3	29	41%	45%	11%	3%
Outside	4	25	12%	20%	20%	48%

<u>Dead Trees</u> Foliage red or none; Cambium dead			Percentage of Insect Responsibility for Condition of Trees			
<u>Zone</u>	<u>No. Plots</u>	<u>No. Trees</u>	<u>None</u>	<u>Secondary</u>	<u>Doubtful</u>	<u>Primary</u>
1	2	42	38%	42%	20%	0
2	3	72	13%	59%	33%	0
Outside	4	17	6%	59%	35%	0

Table 2

Western Yellow Pine
Pinus ponderosa

<u>Green Trees</u>			Percentage of Insect Responsibility for Condition of Trees			
Foliage sickly and sparse; cambium alive.			<u>None</u>	<u>Secondary</u>	<u>Doubtful</u>	<u>Primary</u>
<u>Zone</u>	<u>No. Plots</u>	<u>No. Trees</u>				
1	3	16	100%	0	0	0
2	3	29	97%	0	3%	0
Outside	3	0	---	---	---	---

<u>Dying Trees</u>			Percentage of Insect Responsibility for Condition of Trees			
Foliage fading; or green with cambium discoloring.			<u>None</u>	<u>Secondary</u>	<u>Doubtful</u>	<u>Primary</u>
<u>Zone</u>	<u>No. Plots</u>	<u>No. Trees</u>				
1	3	36	44%	11%	31%	14%
2	3	25	76%	0	20%	4%
Outside	3	24	0	4%	17%	79%

<u>Dead Trees</u>			Percentage of Insect Responsibility for Condition of Trees			
Foliage red or gone; cambium dead.			<u>None</u>	<u>Secondary</u>	<u>Doubtful</u>	<u>Primary</u>
<u>Zone</u>	<u>No. Plots</u>	<u>No. Trees</u>				
1	3	178	15%	29%	56%	0
2	3	114	10%	21%	67%	2%
Outside	3	38	0	5%	21%	74%

APPENDIX

to

Report of

The Role of Forest Insects

as regards

Timber Damage in the Smelter Fire Area

near

Northport, Washington

Plot Examination Data

Zone One Plots

Plot #1. Location: On east side of Columbia River $7\frac{1}{2}$ miles northeast of Northport in S.25, T.40 N., R.40 E. On second river bench.

Soil: Very sandy.

Area: About 20 acres.

Stand: Mixed stand of Douglas fir, yellow pine, larch, lodgepole, and grand fir. Cut over many years ago. Remaining stand of reserve trees and second growth -- mostly of small diameter.

Foliage: Sickly color, only one or two years growth present. Firs dying back with only scanty foliage near trunk of trees.

Examination: July 20, 1929, by F. P. Keen.

Douglas Fir

Insect Responsibility for Condition of Trees

	<u>None</u>	<u>Secondary</u>	<u>Doubtful</u>	<u>Primary</u>
Sickly (foliage still alive, green but sparse)	4 trees	--	--	--
Dying (foliage discoloring)	22 trees	1 tree	5 trees	--
Dead (foliage red or black)	12 "	1 "	5 "	--

Eastern Yellow Pine

Insect Responsibility for Condition of Trees

	<u>None</u>	<u>Secondary</u>	<u>Doubtful</u>	<u>Primary</u>
Sickly	3 trees	--	--	--
Dying	6 "	3 trees	2 trees	--
Dead	7 "	--	11 "	--

Lodgepole Pine

Sickly	12 trees	--	--	--
Dying	6 "	--	7 trees	--
Dead	2 "	--	6 "	--

Grand Fir

Sickly	--	--	--	--
Dying	12 trees	3 trees	--	--
Dead	6 "	--	9 trees	--

Plot #2. Location: West side of Columbia River, 5 miles north of Northport in S. 16, T. 40 N., R. 40 E.

Soil: Very sandy.

Area: About 20 acres.

Stand: Mixed stand of Douglas fir, western yellow pine, lodgepole, and larch; larger trees cut out.

Foliage: Yellow and sickly; only one or two years growth of needles present.

Examination: July 15, 1929, by F. P. Keen.

Condition of Trees: Dead and dying trees showed little work by insects; two yellow pines with old dead, black foliage, found with western pine beetle just attacking the still fresh cambium. Another dying yellow pine showed no evidence of primary tree-killing barkbeetles. Seven dead yellow pines showed scattered mines of western pine beetle, doubtfully primary.

Douglas Firs: Showed no work of primarily destructive species in the six dead and dying trees examined.

Lodgepole pine: No trees were found dying from barkbeetle attack, although foliage was abundantly attacked by aphids.

Larch: No trees were being killed by insects.

Plot #3. Location: West side of Columbia River opposite Northport in S.W. corner of Sec. 30, T. 40 N., R. 40 E.

Soil: Very sandy.

Area: About 80 acres.

Stand: Few scattered yellow pines left after area was logged many years ago. Mostly of medium to small diameters.

Foliage: Sparse and discolored, with only one year's growth of needles.

Examined: November 15, 1929, by Keen and Evenden.

Responsibility of Insects:

	<u>Western Yellow Pine</u>			
	<u>Insect Responsibility for Condition of Trees</u>			
	<u>None</u>	<u>Secondary</u>	<u>Doubtful</u>	<u>Primary</u>
Sickly	6	--	--	--
Dying	3	1	4	4
Dead	6	25*	51	--

* Ten old dead trees with new (1929) attacks of western pine beetle, positively attacking in a secondary capacity.

Plot #4. Location: West side of Columbia River about 2 miles north of Northport in Sec. 19, T. 40 N., R. 40 E. on first river bench.

Soil: Sandy and rocky.

Area: About 10 acres.

Stand: Largely Douglas fir with some larch and western yellow pines. Not cut over. Trees of medium to large diameter.

Foliage: Very sparse and sickly. Trees dying back from top and sides.

Examination: November 20, 1929, by Keen and Evenden.

Douglas Fir

	<u>Insect Responsibility for Condition of Trees</u>			
	<u>None</u>	<u>Secondary</u>	<u>Doubtful</u>	<u>Primary</u>
Sickly	12	--	--	--
Dying	14	3	1	--
Dead	19	37	14	--

Plot #5. Location: West side of Columbia River about 2 miles north of Northport in S. 24, T. 40 N., R. 39 E. on second bench above river.

Soil: Fine sandy loam.

Area: About 20 acres.

Stand: Largely western yellow pine, uncut except for a few of the larger trees. Small amount of Douglas fir. No recent fires.

Foliage: Sparse, with only one or two years growth of needles; slightly discolored.

Examination: By Evenden and Keen - November 20, 1929.

Western Yellow Pine

	<u>Insect Responsibility for Condition of Trees</u>			
	<u>None</u>	<u>Secondary</u>	<u>Doubtful</u>	<u>Primary</u>
Sickly	7	--	--	--
Dying	7	--	5	1
Dead	17	26*	38	--

* Seven dead trees with new attacks (1929) of western pine beetle showing positively that in these cases this tree-killing beetle was attacking in a secondary capacity.

Zone Two Flots

Plot #6. Location: Lower Cedar Creek Valley in NW $\frac{1}{4}$ Sec. 11, T.40 N., R. 41 E. on steep eastern slope 200 feet above level of creek.

Soil: Loam in rocky outcroppings.

Area: About 20 acres.

Stand: Mostly virgin stand of Douglas fir, western yellow pine and white fir, with larger trees cut out. Area was covered with a light ground fire about three or four years ago. Some trees severely burned and weakened by fire.

Foliage: With two or three years of needle growth, somewhat sparse and slightly discolored.

Examination: By Swenden and Keen, November 17, 1929.

Douglas Fir

Insect Responsibility for Condition of Trees

	<u>None</u>	<u>Secondary</u>	<u>Doubtful</u>	<u>Primary</u>
sickly	13	2	1	--
dying	5	5	2	1
Dead	7	21	17	--

White Fir

Insect Responsibility for Condition of Trees

	<u>None</u>	<u>Secondary</u>	<u>Doubtful</u>	<u>Primary</u>
sickly	1	--	--	--
dying	1	1	--	--
Dead	--	1	2	--

- Plot #7.** Location: Lower Deep Creek in Sec. 10, T. 39 N., R. 40 E. near Northport cemetery on bench above creek.
- Soil: Sandy loam.
- Area: About 40 acres.
- Stand: Pure stand of dense, small-diameter lodgepole pine.
- Foliage: Foliage of lodgepole discolored and with only two or three years' growth of needles.
- Examination: By Keen and Evenden, November 16, 1929.
- Insect Responsibility: A few dead and dying trees were found scattered throughout the stand. All of these showed the work of Ips cressoni and Dendroctonus monticolae and apparently had been killed by these barkbeetles. One large group of about 50 green, dying, and dead trees had been and were being killed by Ips cressoni. This attack was primary as far as could be ascertained.
- Plot #8.** Location: Lower Deep Creek in Sec. 14, T. 39 N., R. 40 E., near creek.
- Soil: Sandy loam.
- Area: About 10 acres.
- Stand: Dense growth of mixed species, cedar, Douglas fir, white fir and larch predominating.
- Foliage: Cedar with considerable dead foliage. White fir sickly and dying back.
- Examination: By Keen and Evenden, November 16, 1929.
- Insect Responsibility:
- White Fir (Abies grandis): Nearly all the firs were in a very sickly, dying, or dead condition, with a defoliation and dying back of the tops which apparently had been going on for some time. Ten recently dead trees were all found to be heavily infested with Scolytus ventralis, with broods in the full-grown larval stage. Except for the condition of the tops which apparently antedated the insect attacks, the evidence would indicate that barkbeetles were primary in their attacks.
- Plot #9.** Location: Two miles southeast of Rosburg in Sec. 3, T. 37 N., R. 38 E.
- Soil: Sandy loam with rock outcroppings.
- Area: About 2 acres.
- Stand: Mostly western yellow pines of small diameter, and second growth Douglas firs. No recent fires.
- Foliage: Slightly discolored with two or three years' growth of needles.
- Examination: By Evenden and Keen, November 22, 1929.

Plot #9 (cont'd.)

Insect Responsibility:

Yellow Pines - A few sickly trees showed no evidence of bark-beetles. One dying tree had fresh attacks of western pine beetle evidently primary and 3 dead trees showed more or less work of barkbeetles.

Amelias Fir - Four small dead and dying trees had been killed at the root collar by what was determined as being the honey fungus (Armillaria mellea) with bark-beetles attacking the upper trunk later on.

Plot #10. Location: Two miles south of Bozsburg in Sec. 9, T. 37 N., R. 38 E. on fairly steep hillside above river.

Soil: Sandy.

Area: About two acres.

Stand: Scattered mature stand of western yellow pine. No recent fires have run through the area.

Foliage: With two or three years of growth but discolored to some extent, particularly on certain trees.

Examination: Evenden and Keen, November 22, 1929.

Insects: A few dead and dying yellow pines were found, most of which showed no evidence of barkbeetle work. (These were tabulated with the Plot #11 data which were in every way similar).

Plot #11. Location: Near Evans in Sec. 15, T. 37 N., R. 38 E. on hillside above the Evans-Marcus road.

Soil: Very sandy.

Area: About 40 acres.

Stand: Light stand of mature virgin western yellow pine, with considerable reproduction underneath. No fires have been through here in ten years or more as evidenced by the heavy reproduction six feet or more in height.

Foliage: Two or three years of needle growth, but many trees of a sickly yellow color and with very sparse foliage.

Examination: By Evenden and Keen on November 22, 1929.

Insect Responsibility: Although this plot is probably over forty miles from the smelter, it showed a heavy percentage of sickly and dying trees which were not due to barkbeetle attack.

		<u>Eastern Yellow Pine</u>			
		<u>Insect Responsibility for Condition of Trees</u>			
		<u>None</u>	<u>Secondary</u>	<u>Doubtful</u>	<u>Primary</u>
Green-	sparse and				
	sickly foliage	25	--	--	--
Dying-	foliage and cam-				
	bium discoloring	14	--	1	1
Dead-	foliage red or black	9	16*	20	2

* Three trees with tops dead for sometime had new attacks (1929) of western pine beetle, positively acting in a secondary capacity.

Plot #12. Location: Just north of the river at Marcus in Sec. 27, T. 37 N., R. 37 E., on river flat.

Soil: Sandy gravel.

Area: About 2 acres.

Stand: Second growth yellow pine up to 18 inches d.b.h.

Foliage: Slightly sparse and discolored.

Examination: By Evenden and Keen, November 21, 1929.

Insects: Borer beetles (*Ips grandis* and *Ips integer*) had killed a group of about 80 yellow pines of all diameters. Such killings are typical of the work of these insects where they have been bred up in slashings or windfalls and this particular group killing showed every indication of being a primary insect attack. The source of the infestation was not discovered.

Plot #13. Location: On Fifteen-Mile Creek near the Glasgow Ranch in Sec. 33, T. 39 N., R. 38 E. on upper points and benches above the river.

Soil: Sandy loam with rocky outcroppings.

Area: About 40 acres.

Stand: Scattered stand of Douglas fir, western yellow pine, larch, white fir, lodgepole and other species. The area has been cut over to some extent and frequent ground fires have run over it in the past.

Foliage: Unhealthy in appearance with only two or three years' growth retained, and somewhat discolored.

Examination: By Keen and Evenden, November 19, 1929.

Insect Responsibility: On account of the scattered stand only a few dead and dying trees were located. These showed insect work as follows:

Douglas Fir

Insect Responsibility for Condition of Trees

<u>Condition of Trees</u>	<u>None</u>	<u>Secondary</u>	<u>Doubtful</u>	<u>Primary</u>
Sickly	21	--	--	--
Dying	2	2	--	--
Dead	--	6	1	--

Western Yellow Pine

Insect Responsibility for Condition of Trees

<u>Condition of Trees</u>	<u>None</u>	<u>Secondary</u>	<u>Doubtful</u>	<u>Primary</u>
Green	--	--	--	--
Dying	--	--	--	1
Dead	--	1	4	--

Plot #14. Location: West side of Columbia River, 3 miles southwest of Marble near Mero Ranch in Sec. 2, T. 38 N. R. 38 E.
Soil: Sandy loam among rocky outcroppings.
Area: About 40 acres.
Stand: Very scattered matured yellow pines in pockets between the rocks.
Foliage: Sparse and distinctly discolored.
Examination: By Keen, July 18, 1929.
Insect Responsibility: Several western yellow pines with discolored foliage were examined. None showed insects as the responsible cause. Four dead trees examined showed galleries of western pine beetle with no indication as to whether or not they were primary in their attacks.

Plot #15. Location: On west side of Columbia River, north of Marble near the Crown Creek schoolhouse in Sec. 13, T. 39 N. R. 38 E.
Soil: Loam on rock promontories.
Area: About 5 acres.
Stand: Mixed stand of mature Douglas fir and western yellow pine of poor site quality. No logging has taken place but the area has been visited by frequent ground fires in the past.
Foliage: Douglas fir foliage scant and most trees dying back at tops and extremities. Yellow pine with only one year's growth of needles and these discolored.
Examination: By Keen and Svenden, November 19, 1929.
Insect Responsibility: The yellow pines showed group killing by western pine beetle, to what extent due to weak condition of trees it was impossible to say. No primary insect work in Douglas fir was found.

Douglas Fir

Insect Responsibility for Condition of Trees

<u>Condition of Trees</u>	<u>None</u>	<u>Secondary</u>	<u>Doubtful</u>	<u>Primary</u>
Sickly	10	1	--	--
Dying	7	8	1	--
Dead	2	15	7	--

Western Yellow Pine

Insect Responsibility for Condition of Trees

<u>Condition of Trees</u>	<u>None</u>	<u>Secondary</u>	<u>Doubtful</u>	<u>Primary</u>
Sickly	3	--	1	--
Dying	5	--	4	--
Dead	2	8*	57	--

* One dead tree with western pine beetle making new attack (1929).

Plot #16. Location: West side of Columbia River northeast of Marble in Sec. 17 T. 39 N., R. 39 E.
Soil: Sandy loam.
Area: About ten acres.
Stand: Mature western yellow pine and Douglas fir uncut. (This area was cut over by November 1929). Evidence of old fires.
Foliage: Scant and discolored.
Examination: By Keen and Hopping on July 22, 1929.
Insect Responsibility: Several dead yellow pines were examined and found to have markings of western pine beetle, to what extent primary impossible to say. Many dead and dying Douglas fir were examined, most of which showed no evidence of barkbeetle work and were evidently dying from other causes.

Plot #17. Location: On Sheep Creek 2.6 miles below Patterson in NW 1/4 Sec. 14, T. 40 N., R. 39 E.
Soil: Rocky and gravelly with some loam.
Area: About 2 acres.
Stand: Second growth and cull Douglas fir, larch, white fir and other species. Stand has been severely injured by fire in the past and trees weakened.
Foliage: Sickly and sparse especially on the Douglas fir and grand fir.
Examination: Keen and Evenden, November 18, 1929.
Insect Responsibility: Five white fir examined showed the work of *Scolytus ventralis*, evidently working in a secondary manner as the trees had been previously very heavily killed back at the tops and sides. Four Douglas firs with sickly, dying foliage showed no work by insects. Since the trees had been injured by fire sometime in the past no conclusion as to the primary cause of death could be reached, other than to say that insects were only playing a secondary role.

Plots Outside Zones

Dying and dead trees were so few and far between in the area outside the zones of damage that it was very hard to find trees enough on which to base a comparison. Sample plots were out of the question, and a large area had to be covered. Any dead or dying trees found along the way were examined as to cause of death.

A few centers where insects were actively killing trees were found, but for the most part the outside forest was in a very healthy vigorous condition. These centers are indicated on the map accompanying this report.

Plot #18. Location: West of Cedar Lake in SW $\frac{1}{4}$ Sec. 27, T. 40 N., R. 41 E. on east slope of mountain range.

Soil: Loam.

Area: About 2 acres.

Stand: Heavy growth of virgin uncut Douglas fir, white fir, larch, and yellow pine.

Foliage: Normal healthy dense foliage, with more than three years' needles retained.

Examination: Keen and Evenden, November 17, 1929.

Insect Responsibility: On this area we found a typical group killing of Douglas fir by the Douglas fir beetle (*Dendroctonus pseudotsugae*) with some work by *Melanophila drumondii*. Trees with normal green foliage were heavily attacked and the cambium was dying. Other trees were dying, with yellow to red foliage. Some work of what was determined as being the honey fungus (*Armillaria mellea*) was found at the root collar and may have been a contributing cause of death.

Douglas Fir

Insect Responsibility for Condition of Trees

<u>Condition of Trees</u>	<u>None</u>	<u>Secondary</u>	<u>Doubtful</u>	<u>Primary</u>
Sickly	--	--	--	--
Dying	--	1*	5	12
Dead	--	2*	4	--

* *Armillaria* appeared to be the primary cause in these cases.

White Fir

Insect Responsibility for Condition of Trees

<u>Condition of Trees</u>	<u>None</u>	<u>Secondary</u>	<u>Doubtful</u>	<u>Primary</u>
Sickly	--	--	--	--
Dying	--	--	1	4
Dead	--	--	--	--

Plot #19. Location: On Pinkton Creek, 5 miles east of Marcus, in Sec.2,
T. 38 N., R. 38 E.

Soil: Loam.

Area: A few scattered patches on 640 acres.

Stand: Fairly good stand of Douglas fir, larch and western
yellow pine. Portions of area cut over and burned
to some extent.

Foliage: Normal to slightly discolored.

Examination: Evenden and Keen, November 21, 1929.

Insect Responsibility: Eight Douglas firs were found to be dying
or recently dead. All except one tree were found to
be attacked at the base by what was determined as the
honey fungus and this was apparently the cause of death.
Two large trees, 20 to 30 inches in diameter, were found
with normal green foliage, but with the cambium at the
root collar completely killed by the fungus. No
insects were present. Others nearby were in a similar
condition with barkbeetles just attacking the fresh
cambium of the upper bole. Others which were dead
showed the work of the fungus at the base and secondary
barkbeetle work above, or a few scattered galleries of
primary species. All of these cases showed conclu-
sively that the insects were secondary to the injury
by the fungus. The other Douglas fir was a lightning-
struck tree with barkbeetles just entering.
One dying yellow pine was found with barkbeetle attack
but it had been struck previously by lightning.

Douglas Fir

Insect Responsibility for Condition of Trees

<u>Condition of Trees</u>	<u>None</u>	<u>Secondary</u>	<u>Doubtful</u>	<u>Primary</u>
Sickly	--	--	--	--
Dying	1*	3*	1 ^o	--
Dead	--	2*	1	--

* Armillaria the responsible agent, apparently.

^o Lightning struck.

Plot #20. Location: West side of Columbia River near Kettle Falls bridge in Sec. 11, T. 36 N., R. 37 E.

Soil: Very fine sand.

Area: Two groups of trees each on about an acre.

Stand: Mature yellow pine of fair quality and medium diameters in nearly pure stand. One area had a light ground fire in the fall of 1928, or spring of 1929.

Foliage: Slightly discolored and with two or three years' growth of needles.

Examination: Keen and Evenden, November 21, 1929.

Insect Responsibility: About 30 trees were found with dying tops. Upon felling some it was found that this was due to attacks by engraver beetles (*Ips integer* and *Ips arizoni*). In some cases the western pine beetle *Parquetomus brevicornis* was filling in the attack on the lower bole. All of this work appeared to be the result of primary insect attack, such as is frequently found in any yellow pine forest.

Plot #21. Location: On the slope of Kettle River near Burstow in Sec. 15, T. 36 N., R. 37 E.

Soil: Loam on rocky hillside.

Area: About 2 acres.

Stand: Scattered stand of mature western yellow pines and Douglas fir, uncut and not recently burned.

Foliage: Normal with three or more years' growth of needles retained.

Examination: Keen and Evenden, November 21, 1929.

Insect Responsibility: Five dead yellow pines were noted. One had been top-killed by *Ips* barkbeetles; one killed by mountain pine beetle and three had the work of western pine beetle. From all indications this work was of a primary nature.

Summary for Plots 20 and 21

Western Yellow Pine

Insect Responsibility for Condition of Trees

	<u>None</u>	<u>Secondary</u>	<u>Doubtful</u>	<u>Primary</u>
Sickly	--	--	--	--
Dying	--	1	4	15
Dead	--	2	4	28

REPORT OF INVESTIGATIONS OF INSECT DAMAGE TO
FOREST TREES IN THE SMELTER FUME AREA NEAR NORTHPORT, WASHINGTON

by
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At the suggestion of the Commission studying the smelter fume damage in the vicinity of Northport, Washington, the Bureau of Plant Industry requested the Bureau of Entomology to send a forest entomologist into the area to determine to what extent insects had been a factor in killing trees in that vicinity.

The Bureau of Entomology delegated the writer to make this inspection and the area was visited on July 17th and a week spent in company with Dr. Geo. G. Hedgcock of the Bureau of Plant Industry in determining the forest insects present and in making an appraisal of their damage. In the short time available it was obviously impossible to make a quantitative survey of the damage even on sample plots, and the results of the inspection must be considered as qualitative only.

Localities Visited

The area inspected included the west side of the Columbia River from eight miles north of Northport to thirteen miles south, in the vicinity of the Moore and Dany Ranches. On the east side of the Columbia River the area from Marcus to nine miles above Northport was inspected. The area in the vicinity of Trail and Roseland in the heavily damaged smoke belt was studied. The inspection also included the valley of Deep Creek to five miles south of Spirit; the valley of

Little Sheep Creek north to Patterson; Big Sheep Creek from its mouth to Keil Cabins and Pierre Creek from the summit of the divide to Orient; and the Kettle River valley from Rockcut to Marcus. Thus the inspection covered the major part of the area under dispute as well as some of the adjoining areas where there was no question of smoke damage.

FOREST TREE SPECIES CONSIDERED

Since the investigation was concerned with economic damage to forest trees, only such trees as were considered as of value for timber were included. This limited the investigation to the following species of conifers:

Western yellow pine	<i>Pinus ponderosa</i>
Douglas fir	<i>Pseudotsuga taxifolia</i>
Western larch	<i>Larix occidentalis</i>
Western white pine	<i>Pinus monticola</i>
Lodgepole pine	<i>Pinus contorta</i>
Western red cedar	<i>Thuja plicata</i>
Grand fir	<i>Abies grandis</i>
Alpine fir	<i>Abies lasiocarpa</i>
Engelmann spruce	<i>Picea engelmannii</i>
Mountain hemlock	<i>Tsuga mertensiana</i>

There are a number of broad leaf trees on the area but none of commercial importance, hence their insect enemies were not considered.

PRIMARY AND INJURIOUS INSECT ENEMIES OF THE COMMERCIAL CONIFERS

Most of the commercial conifers in this region have primary injurious insect enemies. Primary enemies are those capable of injuring trees unaided by other causes. There are others which only act as secondary agents and are not capable of killing or injuring trees on their own accord. Such secondary insects although numerous on the Northport area need not be taken into consideration as factors in the tree damage.

On the Northport area the following primary insect enemies were found attacking the coniferous trees listed above. The trees are considered in order of their commercial importance and abundance.

1. Douglas Fir (Pseudotsuga taxifolia)

Douglas fir is the most abundant tree in the region and is widely distributed throughout this area. It occurs in particularly heavy stands at the upper elevations where it is mixed with very few other species.

The Douglas fir tussock moth (Hemerocampa resoluta Moel.) was the most serious pest found in the timber of the region. Large areas at the higher elevations were being partially to completely defoliated and much timber will undoubtedly die. This moth which has been previously noted only in Canada is evidently well established in the region and may cause widespread destruction. On some of the areas examined the old cocoons showed positively that this was at least the second year of its work in this area. Since at present the killing of Douglas fir by this moth and caterpillar occurs only at the higher elevations there is little chance of confusing its work with the smelter fume damage. Defoliation of trees from caterpillar work can be distinguished by the presence of the old cocoons on the branches, a slight webbing together of the chewed needles, and the fact that the caterpillars strip the needles from the trees from the top downward, often leaving considerable foliage on the lower limbs.

The Douglas fir beetle (Dendroctonus pseudotsugae Hopk.) was found killing a few scattered groups of trees at the higher elevations. In the heavily defoliated areas a few galleries of these beetles might be found on the north side of the trees, but not in sufficient numbers to account for the trees' death. The damage to Douglas fir from this cause is very slight on this area.

The Douglas fir flathead (Melanophila drummondii) was found making its galleries in heavily defoliated and dying trees. Most of its work was undoubtedly secondary in nature, as it was never found in healthy trees.

Coeley's Chermes (Adelges coelesti Gill.) was found abundantly on the foliage of Douglas firs both in and outside of the smoke zone. It causes a discoloration or spotting of the needles but is not considered to ever be fatal to these trees, and in the present instance did not appear to be seriously injuring them.

The spruce budworm (Pezomachus fumiferana Clem.) was found in limited numbers outside of the smoke zone feeding on the tips of young Douglas firs. It was not found abundantly in any of the areas visited and did not appear to be doing much damage.

2. Western Yellow Pine (Pinus ponderosa)

Along the lower slopes of the Columbia River valley, western yellow pine was found in considerable quantities, although much of the best had already been logged many years ago.

The western pine beetle (Dendroctonus brevicornis Lec.) was found killing scattered trees in the mature and overmature classes. The infestation was very typically an endemic or "normal" infestation such

as is so commonly found in western pine stands throughout the western states. On this area the loss would not exceed one tree per year for every ten acres of land timbered with mature western yellow pines. On the cut-over and second growth areas the loss from this source was negligible. On the heavily defoliated areas trees with black tops which appeared to have been dead for several years were found to have fresh cambium with these barkbeetles just making their first attacks.

The Oregon engraver beetle (Ips oregoni Richh.) was found killing a very few seedlings and poles which had been partly weakened by fire or other causes. This type of work was not abundant.

The red turpentine beetle (Resinectonus valens Lec.) was found attacking butts of heavily defoliated and dying trees. It is rarely considered a primary enemy of western yellow pines and usually attacks trees dying from other causes, or assists other barkbeetles in killing the trees.

The pine leaf scale (Chionaspis pinifoliae Fitch) was found in scattering numbers on the foliage doing no apparent damage.

A few aphids were also found on the foliage but appeared to be causing little or no injury.

No defoliating insects were found on the western yellow pines.

3. Western Larch (Larix occidentalis)

Larch is one of the important commercial trees of the region and on many places throughout the area is quite abundant. However, there are no important primary insect enemies of the larch in this region and no trees were found on this area which could be considered as having been killed or even seriously injured by insects.

The larch roundheaded borer (Tetropium valutinum) was found mining the cambium of dying, dead, and felled larch, but in every case was very decidedly a secondary enemy.

The Douglas fir engraver (Scolytus unispinus) was found under the bark of a few dead trees and was also observed burrowing in the tips of very small twigs causing them to die.

A flatheaded borer was also found breeding in dead trees.

b. Lodgepole Pine (Pinus contorta)

Lodgepole pine is scattered throughout the area, but is of small diameter and of little economic value in this region. At the lower elevations most of the best was cut when the country was logged over many years ago, and virgin stands of fairly large size trees are only found at the upper elevations.

The mountain pine beetle (Dendroctonus monticolae Hopk.) which is a very destructive enemy of this tree in some regions, was only found at isolated localities in the area around Northport, and was only found killing trees at the upper elevations in the virgin stands. The second growth and cut-over stands showed very little damage from this beetle.

The engraver beetles (Ips arizonae etc.) were found breeding in trees which had been severely defoliated and were probably aiding in their ultimate death. For the most part their work was secondary.

Aphids and scales were found on the foliage of this pine in some regions, but seemed to be causing very little if any damage. In some places the aphids and their accompanying honeydew were particularly abundant.

5. Western White Pine (Pinus monticola)

This tree was not very abundant on the area and was only found mixed with other species at the higher elevations.

No insects were found killing this tree on the area.

Aphids and scales had galled and discolored the foliage to a limited extent in some places.

6. Western Red Cedar (Juniperus plicata)

This tree is very rarely killed by insects and then only in connection with injury from other causes. No insect killing was noted on the Northport area where the tree is found scattered through the stands at the higher elevations.

7. Grand Fir (Abies grandis)

This fir was found scattered through the stand, but probably does not occur in commercial quantities, especially since it is not considered as a valuable timber tree.

The white fir engraver (Scolytus ventralis) is quite capable of killing grand fir unaided by other agencies. Some of the work of this insect was found on the Northport area but it was not plentiful and appeared to be a secondary factor in the death of these trees.

The Douglas fir tussock moth (Panorpanna pseudotsugae) was found defoliating this tree at the higher elevations where mixed with Douglas fir. It did not seem to be the preferred host however.

8. Alpine Fir (Abies lasiocarpa)

This tree is not abundant or of such commercial significance on the Northport area.

No destructive insects were found attacking it.

9. Engelmann Spruce (Picea engelmanni)

This tree is relatively scarce in the Northport region.

No destructive barkbeetles were found attacking this tree.

Cooley's Chermes (Adelges cooleyi) galls were found quite abundantly on the twigs. These rarely, if ever, cause the death of a tree.

10. Mountain Hemlock (Tsuga mertensiana)

No insects were found attacking this tree which is rare in the area and only found at the higher elevations.

TIMBER DAMAGE FROM INSECTS ON DIFFERENT AREAS

In the heavily damaged smoke zone in close proximity to the smelter at Trail and near Roseland, trees examined showed little or no insect work. In fact insects were conspicuous by their absence, and only a few scattering weak broods were found in the dying or dead trees. Perhaps the smoke here acts as a fumigant to discourage insect attack.

In the outer belt of smoke injury, more insect work was found. Here the weakened condition of the trees offered favorable breeding conditions for the insects without the repellent effect of the heavy smoke.

In areas remote from any possible smoke injury, the loss from insects was again very light.

This distribution of insect damage is analogous to that found around heavily burned areas. In the middle of the burn where trees

have been completely defoliated, the work of primary tree killing insects is decidedly negligible; while on the margin of the burn where the trees have only been scorched and weakened by the fire there is usually a concentration of barkbeetle attacks and a heavy loss from this source. This condition is illustrated around the heavy burns of Upper Deep Creek, eight miles south of Northport.

East Side of Columbia River North of Northport

A detailed examination was made on the NE $\frac{1}{4}$ of Section 20, T. 4 N., R. 41 E. on the east side of the Columbia River about eight miles north of Northport (Dr. Hodgecock's Plot #34). One hundred and forty live, dying, and dead trees of various species were examined and a check made of the amount of insect work in each.

Douglas Fir. Forty-eight trees were examined. The live trees showed no insect work, although many or most of the trees were heavily defoliated and appeared to be in a weakened condition. The dying trees in 20 per cent of the cases showed some barkbeetle work, but in every instance this consisted of a few scattering galleries usually on the north side of the trees only. The amount of such work was so limited that it could hardly be considered that the trees were dying from this cause. Eighty per cent of the dying trees showed no primary insect work, and most of these did not have any insect work of any description.

Western Yellow Pine. Twenty-eight trees were examined. None of the live trees showed insect work. Twenty-five per cent of the dying trees showed attacks by the western pine beetle, which might be considered

as having caused their death, or at least in contributing to their death. Forty per cent of the dead trees showed no barkbeetle work of primary species. Three of the old dead trees with black foliage had live cambium with the barkbeetles just making their attacks.

Western Larch. As usual this tree showed no damage from insects.

Lodgepole Pine. Thirty-five trees were examined. No barkbeetles were found attacking the living trees. Fifty per cent of the dying trees showed insect attack; but the barkbeetles found in these trees were for the most part the engraver beetles (Ips spp.) which ordinarily do not kill any large quantities of timber. In this case they appeared to be secondary to other causes. Twenty-five per cent of the dead trees showed no barkbeetle work of any description.

Grand Fir. Thirty trees were examined. No living trees were found. Twenty per cent of the dying trees showed struggling attacks of the fir engraver (Scolytus ventralis) while 50 per cent showed no insect work. Forty per cent of the dead trees showed no barkbeetle work. Of the dead trees showing barkbeetle work there is no way of telling whether or not the beetles were primary or secondary.

After trees are dead it is too late to decide what was the primary cause of their death, except that where no insects are found and no evidence of their work is found it can hardly be charged to their activity. It is very evident on the above area that insects are only a contributing cause of the death of the trees.

West Side of Columbia River North of Northport

An examination of a plot in Section 16, T. 40 N., R. 40 E. (Dr. Hedgecock's Plot #12) was made to determine insect damage in that vicinity.

Douglas Fir. No insect work of primarily destructive species was found in six dead and dying trees examined.

Western Yellow Pine. Two trees with completely dead foliage (black tops) were found to have fresh cambium with the western pine beetle just making their attacks. This is conclusive evidence that in this case this ordinarily primary tree killer was acting as a secondary agent. Another dying tree showed no evidence of primary tree-killing barkbeetle. Seven dead trees examined showed scattering mines of western pine beetle, but of course, did not show whether these trees had been attacked by beetles before or after death.

Lodgepole Pine. No trees dying from barkbeetles were found on this area. Aphids were very abundant on the foliage but seemed to be causing no noticeable damage.

Western Larch. Dying larch showed no indications of having been killed by insects. Trees dying from any cause were not abundant.

Sheep Creek Drainage

On the lower part of the Sheep Creek drainage about the same conditions prevailed as on the lower slopes of the Columbia River. Although many trees were dying very few appeared to be due to insect attack.

In the upper reaches, the forest was exceptionally free from insect killing.

West Side of Columbia River South of Northport

Douglas Fir. As far south as the Moore and Denny Ranches the Douglas fir showed defoliation which was not due to insects. A few of these trees had the Douglas fir beetle (Dendroctonus pseudotsugae) just making its attack and some of the dead trees had galleries of flatheaded borers. However, all of this work appeared to be secondary to the injury from defoliation. Chermes work on the needles of young firs was abundant and caused spots of discoloration.

Western Yellow Pine. An endemic infestation of the western pine beetle in western yellow pine was noted along the lower slopes and benches of the Columbia River drainage. This infestation has been killing mature trees annually over a long period of time at a rate not to exceed one tree to ten acres annually. Considerable discoloration and premature shedding of needles was found, but this could not be traced to any insect activity.

Larch. As in all other areas the larch was not being killed by insects.

Mountains West of Columbia River

The very heavy epidemic of the Douglas fir tussock moth, previously mentioned, was found on the upper slopes and ridges of the mountains lying west of the Columbia River opposite Northport. This epidemic was particularly severe at the head of Crown Creek and Flat Creek and extended on across the divide to Pierre Creek. It has also been reported on both sides of Carlew Creek from Grand Forks, B.C. to Carlew, Wash. Most of the defoliated area lies within the boundaries

of the Colville National Forest. Over hundreds of acres the needles have been completely stripped from the firs and they are sure to die, while partially defoliated patches extend in all directions. For the most part the moth defoliation lies at the higher elevations above the zone injured by smelter fumes. The two types of injury can hardly be confused, especially upon close examination. Old cocoons on the branches gave evidence that the epidemic had been in progress for at least two years.

East Side of Columbia River South of Northport

There is very little timber of any description in this part of the area, especially at the lower elevations in the possible zone of smelter damage.

Douglas firs which were examined showed varying degrees of defoliation and appeared to be slowly dying, but there was no evidence that insects were responsible for this condition.

A few scattering yellow pines were evidently dying from insect attack; but the amount of this work was much less than that found across the river.

Deep Creek Drainage East of Northport

Insect work in the Deep Creek watershed was also very slight.

Douglas firs were noted to be dying in small patches evidently from Douglas fir beetle attacks. These small groups were noted both in the lower part of the drainage and far back on the upper slopes; and was especially noticeable on the margins of recent burned areas. Two small

patches of tussock moth defoliation were noted high up on the slopes east of the Creek.

Other species of trees were decidedly healthy and showed practically no insect damage.

CONCLUSIONS

In general, the timber which was inspected within a thirty-mile radius of Northport, Washington, was found to be quite free from insect damage, other than that caused by the Douglas fir tussock moth.

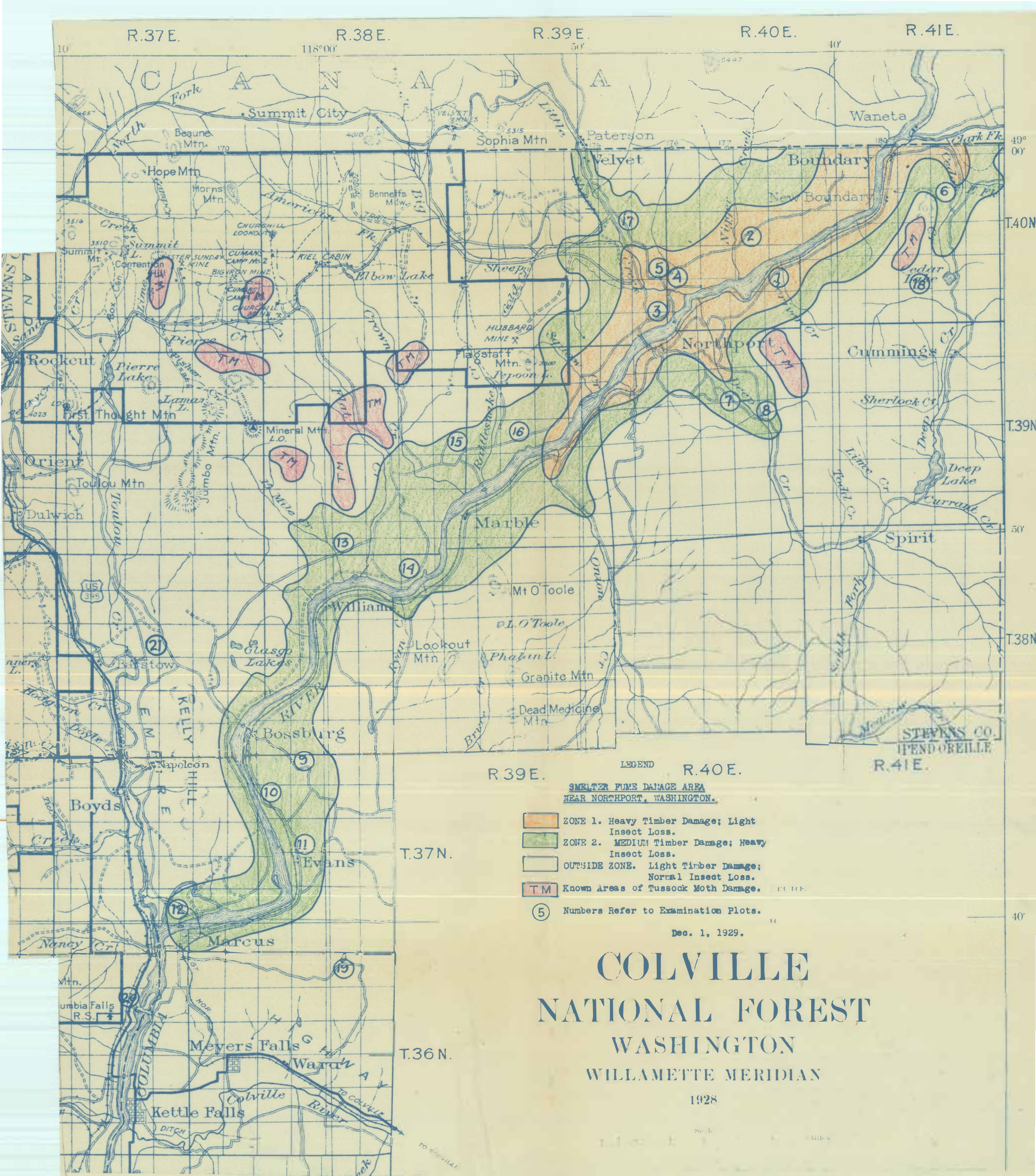
Tussock moth damage is very extensive and severe but as yet is confined to the higher slopes and ridges in areas outside of the accepted zone of smelter fume injury.

In the zone of severe smelter damage, destructive insects were conspicuous by their absence, and in the opinion of the writer none of the damage in this area can be attributed to them.

The heaviest damage, other than tussock moth defoliation, was in the zone of partial smelter fume injury. Here the loss to western yellow pine from barkbeetles was about as heavy as that normally found in over-mature stands of this species. However, this endemic loss chargeable to barkbeetles would not exceed one tree to every ten acres of mature forest. The death of Douglas fir in this zone was only partially the result of insects acting as secondary agents, with practically no primary insect damage in evidence. In lodgepole pine the insects appeared to be entirely secondary although contributing to the death of many trees which had been severely defoliated. The insect damage to other tree species was negligible.

Outside of the zone of smelter injury the only severe damage was being caused by the Douglas fir tussock moth in the Douglas fir stands at the higher elevations. The Douglas fir beetle was also killing small patches of trees, particularly on the margins of burns. Killing of western yellow pine was very slight. Small groups of lodgepole were dying from mountain pine beetle attack. The other tree species were all decidedly healthy and insect damage was almost totally absent.

In general then it may be said that insects are playing only a very minor role in the damage to forest trees within the smelter fume area of the upper Columbia River drainage near Northport, Washington, and the dying of trees in this area, for the most part, must be chargeable to other causes.



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LEGEND

SMELTER FUME DAMAGE AREA
NEAR NORTHPORT, WASHINGTON.

ZONE 1. Heavy Timber Damage; Light Insect Loss.

ZONE 2. MEDIUM Timber Damage; Heavy Insect Loss.

OUTSIDE ZONE. Light Timber Damage; Normal Insect Loss.

TM Known Areas of Tussock Moth Damage.

⑤ Numbers Refer to Examination Plots.

Dec. 1, 1929.